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Vinson/Taya
editors

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Foreword

This publication, *Recent Advances in Composites in the United States and Japan*, contains papers presented at the United States/Japan Symposium on Composite Materials which was held in Hampton, Virginia, 6-8 June 1983. The symposium was sponsored by ASTM Committees D-30 on High Modulus Fibers and Their Composites and E-9 on Fatigue in cooperation with the National Aeronautic and Space Administration. Jack R. Vinson and Minoru Taya, University of Delaware, served as symposium chairman and secretary, respectively. Jack R. Vinson and Minoru Taya are editors of this publication.

Related ASTM Publications

Effects of Defects in Composite Materials, STP 836 (1984), 04-836000-33

Long Term Behavior of Composites, STP 813 (1983), 04-813000-33

Composite Materials: Testing and Design (6th Conference), STP 787 (1982), 04-787000-33

Damage in Composite Materials, STP 775 (1982), 04-775000-30

Test Methods and Design Allowables for Fibrous Composites, STP 734 (1981), 04-734000-33

A Note of Appreciation to Reviewers

The quality of the papers that appear in this publication reflects not only the obvious efforts of the authors but also the unheralded, though essential, work of the reviewers. On behalf of ASTM we acknowledge with appreciation their dedication to high professional standards and their sacrifice of time and effort.

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SUMMARY

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Introduction

The Second United States-Japan Conference on Composite Materials was held on 6-8 June 1983 at the NASA Langley Research Center, Hampton, Virginia. It was sponsored by the American Society for Testing and Materials Committees D-30 on High-Modulus Fibers and Their Composites and E-9 on Fatigue in cooperation with the National Aeronautics and Space Administration. The conference presented, reviewed, and critiqued all the latest developments in composite materials occurring in both the United States and Japan.

The conference was the successor to the First Japan-United States Conference on Composite Materials, which was held in Tokyo in January 1981.

The chairman of American Organizing Committee for both conferences was Jack R. Vinson, University of Delaware, and the chairman of the Japanese Organizing Committee for both Conferences was Kozo Kawata, University of Tokyo. The American Organizing Committee for this conference included C. W. Bert, C. C. Chamis, A. Dhingra, K. Reifsnider, W. J. Renton, G. L. Roderick, R. Schapery, R. L. Sierakowski, R. Signorelli, M. Taya (secretary), W. J. Walker, S. S. Wang, and C. Zweben. Appreciation is hereby expressed to each committee member for his part in making the conference a great success, especially to G. L. Roderick for his help in providing the conference place. A third conference is being planned for 23-25 June 1986, Tokyo, Japan.

Appreciation is also expressed to the E. I. duPont de Nemours and Company, General Dynamics-Fort Worth, and the Vought Corporation for their financial support.

This volume provides the reader with a very complete set of timely papers that were presented at the conference. These represent the very latest findings in both countries in this rapidly developing area of science, engineering, and technology.

J. R. Vinson

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Fracture

Hiroshi Fukuda[1]

Load Concentration Factors in a Chain-of-Bundles Probability Model

REFERENCE: Fukuda, H., **"Load Concentration Factors in a Chain-of-Bundles Probability Model,"** *Recent Advances in Composites in the United States and Japan, ASTM STP 864*, J. R. Vinson and M. Taya, Eds., American Society for Testing and Materials, Philadelphia, 1985, pp. 5-15.

ABSTRACT: A chain-of-bundles probability model is often used to predict the strength of unidirectional composites. In this model, it becomes necessary first to calculate stress redistribution due to fiber breakage. A rather simple estimation of this stress redistribution has hitherto been conducted. This paper examines it in a more precise manner by adopting a shear-lag assumption. Both ordinary composites and hybrid composites are analyzed. Two idealized models are chosen in the analysis: (1) an infinite model in which a group of broken fibers is embedded in an infinite number of continuous fibers, and (2) a repeating model in which broken fibers appear repeatedly. Actual load concentration factors will fall in between the above two extreme cases. Results of load concentration factors are presented in terms of the number of fractured fibers. The present analysis provides data for a statistical calculation of the strength of composites.

KEY WORDS: load concentration factor, chain-of-bundles probability model, shear-lag, hybrid composites

The strength of a unidirectional composite is often predicted by a rule of mixtures. But this rule is only an approximate solution and, hence, more precise calculation becomes necessary. A statistical approach is an effective tool to understanding the failure of a composite in a more precise manner. This approach assumes that the strength of each fiber is not unique. When a tensile load is applied to the unidirectional composite, the weakest fiber will break first and a stress redistribution will take place. Next, failure must be considered under this redistributed stress field. Thus, it is first of all necessary to calculate the stress distributions around discontinuous fibers, in other words, to evaluate so called load sharing rules [*1*].

The first and simplest rule is an equal load sharing (ELS) rule. This rule

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